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Effect of drying methods and pre-drying treatments on chemical quality of wood apple pulp powder

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Abstract
The mature wood apple was procured from the local market at bolpur district of West Bengal. Some of the wood apple were treated with hot water and some of them were treated with normal water, then scooped out the pulp with seed from hard shell with the help of spoon, dried the pulp by sun drying and hot air oven drying at 450C and ground the dried pulp in the mixer grinder and formulate the powder. KMS of concentration 0.5% and 1% are added to the powder. By this research it was found that, a good quality value added product produced from this fruit in the form of dried powder, as this fruits have some special medicinal and nutritive value. The prepared wood apple (*Limonia acidissima* L.) pulp powder were compared for its chemical properties like acidity, ascorbic acid, TSS, TSS/acid ratio, pH, sugar, ash content, moisture content, total phenol content etc and nutritional properties. The wood apple pulp gets completely dried within 25-30 hours in both of the drying methods. At drying, Nutrients get concentrated except vitamin C and pH that were lost on drying. So, dried wood apple pulp powder retains more nutrients than fresh the one. There is no more such of pre drying treatments on the qualities of wood apple pulp powder. The quality is mainly effected by the drying methods. Different sun drying and oven drying methods had significant effect on changes in chemical quality of wood apple pulp powder. Oven dried fruit powder had the highest, moisture (6.0%) TSS (20.80%), AA (490µ g) and pH (4.80) value and TSS/TA (20.80) ratio, lower TA and shorter time of drying. Sun dried fruit powder had lower moisture (5.25%),TSS, AA and pH value and TSS/TAratio and higher, total phenol content (6.87mg), TA (12%) and longer time of drying (Workneh *et al* 2012). Sun drying is cheaper, easier and cost-effective than oven drying and also remove more moisture than oven drying. Organoleptically, the hot air oven dried sample was liked very much in terms of its appearance, colour and flavor. So, in terms of chemical and nutritional properties sun dried wood apple pulp powder exhibited highest index than oven dried. Hence the wood apple pulp could be dried effectively using sun drying, preserved as dried powder and value added for its industrial exploitation. Since sun drying is also cost effective, the wood apple pulp could be sun dried, formulated into powder and utilized for the preparation of jam, jelly and other products with good gelling nature even during off-season.

Keywords: sun drying, oven drying, wood apple pulp powder

Introduction
Wood-apple is a medium-sized deciduous tropical tree belongs to family Rutaceae. It is common to the dry districts of India as well as the dry and (some of the wet) territories of Sri Lanka (Simons *et. al*., 2005). The fruit is a hard-shelled many seeded berry with its pinkish brown aromatic sour – sweet pulp being the edible portion, the seeds embedded in it. The ripe fruit pulp can be consumed either fresh or processed into high value and extremely popular products such as jams, jelly, chutney, sherbet and cordials.100 grams of wood apple pulp contains 140kcal. The fruit contains carbohydrates and proteins. It is also rich in beta carotene, vitamin B, vitamin C, thiamin and riboflavin. Wood apple fruits that grow in the wild tend to have more tannin than those cultivated for commercial purposes. Wood apple is a nutrient rich fruit which contains a surprisingly high amount of protein (3-7) and low levels of sugar and carbohydrates compared with many other fruits. Additionally the pectin content of the fruit pulp is 3-8. The fruit pulp contains 31g% of carbohydrate and 2g% of protein, which adds up to nearly 140 calories. The wood apple is rich in Beta carotene, a precursor of vitamin –A which also contains significant quantities of the vitamins B such as thiamine and riboflavin and small amounts of vitamin C. Wood apple is useful in preventing and curing scurvy and in reliving flatulence. Wood apple fruit contains flavonoids, glycosides, saponins and tannins. There are reports that some coumarins and tyramine derivatives were also isolated from the fruits of Limonia (Ilango and Chitra, 2009) [9]. All the parts of Limonia are prescribed in indigenous system of medicine for the treatment of various ailments. Fruits are refrigerant, stomachic, stimulant, astringent, aphrodisiac, diuretic, cardiotonic, tonic to liver and lungs,

cures cough, hiccup and good for asthma, consumption, tumours, opthalmia and leucorrhoea. Unripe fruit is astringent while seeds are used in heart diseases. The fruits are used as a substitute for bael (*Eagle marmelos*) in diarrhea and dysentery.

Realizing the importance of fruits as a significant contributor to human well being, as a cheaper and better source of protective foods, their perishable nature and seasonality in production calls for preservation of them to be supplied throughout the year for human consumption. This study was planned keeping in view the nutritional importance of wood apple, to utilize them by preserving them as fruit pulp powder. While considering all these, the present work was carried out to prepare wood apple pulp powder by different methods of drying and to determine the best method of drying as per the chemical and nutritional quality characteristics on drying. Keeping this view in mind the experiment was undertaken with the following objectives:

- To analyze the proximate composition of wood apple
- To prepare wood apple pulp powder by different methods of drying and to determine the best method of drying as per the chemical quality characteristics on drying
- To evaluate the chemical quality of the prepared fruit pulp powder.

Materials and Methods

Fruits

The mature wood apple was procured from the local market at bolpur district of West Bengal. Wood apple pulp powder the pulp was scooped out with seed from hard shell with the help of spoon, dried pulp by using sun drying and hot air oven drying at 45 °C, then ground the dried pulp into mixer grinder to formulate the fine powder. KMS of concentration 0.5% and 1% are added to the powder.

Treatments

Two types of drying method was used, one is sun drying and the another one is hot air oven drying, in combination with hot water treatment and normal water treatment. Two KMS concentrations 0.5% and 1% were used. Therefore, 12 treatment combinations with 3 replications were used in this experiment.(T1=H1D1K1=Hot water treatment + sun drying + KMS 0.5%,T2=H1D1K2=Hot water treatment + sun drying +KMS 1%,T3= H1D2K1=Hot water treatment + oven drying + KMS 0.5%,T4=H1D2K2=Hot water treatment + oven drying +KMS 1%,T5=H2D1K1=Normal water treatment + sun drying + KMS 0.5%,T6 =H2D1K2=Normal hot water treatment + sun drying + KMS 1%,T7 =H2D2K1=Normal water treatment + oven drying +KMS 0.5%,T8 =H2D2K2=Normal water treatment + oven drying +KMS 1%,T9=H1D1K0=Hot water treatment + sun drying +without KMS,T10=H1D2K0=Hot water treatment + oven drying +without KMS,T11=H2D1K0=Normal water treatment + sun drying +without KMS,T12=H2D2K0=Normal water treatment + oven drying + without KMS).

Methodology

The fruit pulp powders were determined for its chemical properties such as Titrable Acidity (%),Ascorbic acid (mg 100g-1), pH, TSS (%),Sugar acid ratio(TSS:TA ratio),Reducing sugar (%), Non-reduing sugar (%),.Total sugar (%),Total phenolic content (mg/100g) and Ash(g). Titrable acidity, Acorbic acid and ash content determined by A.O.A.C (2007) method. Reducing, non-reducing and total sugar are determined by Ranganna (1991) [17] method. TSS determined ny Abbe refractometer and pH determined by pH meter.Total phenolic content (TPC) was measured by Folin − ciocalteau method explained by Singleton and Rossi (1965) [20].

Statistical analysis

The experiment was laid out in Complete Randomized Design. Data obtained on various characters were analyzed statistically according to the analysis of variance techniques. The analysis of variance for different parameters is presented in appendices. The critical difference (CD) was calculated to access the significance or non-significance of difference between treatment means. Wherever, it was found significant through 'F' test at 1 per cent level of significance, marked as star in ANOVA Tables.

Result and Discussions

Titrable acidity (TA) (%)

Acidity was calculated on the basis of titrable acidity based on citric acid. The acidity of treatments T6 (12%) and T11 (12%) is significantly highest among all the treatments followed by T2 (11.09%) and T9 (11.90%) then T1 (11.70%) and T5 (11.50%). The lowest titrable acidity is found in T3 (10.10%) followed by T8 (10.20%). The observation showed that the titrable acidity of sun dried sample, that was pre-treated with normal water and KMS 1% has more acidity than other samples. The increment of TA in sun drying samples may be due to the conversion of carbohydrate to this acid through extended time of drying. More loss of TA in hot water treated sample may be due to subjected to more heat in pre drying treatments. (Table.no4)

TSS

The highest TSS (%) was found in T3(20.80%) and the lowest was in T2(19.50%).There was no effect of pre water treatment on TSS, but drying method significantly affected the TSS of dried samples. Hot air oven dried samples with 1% KMS had more TSS than sun dried samples. (Table no.4)

Total soluble solid to acid ratio

Drying methods had significant effect on the TSS to TA ratio. TSS to acid ratio was found to be highest in T3 (2.05) and lowest in T2(1.64).Oven dried sample that was pretreated with hot water and 0.5% KMS had more TSS/TA ratio.(Table o.4)

pH Value

From the observations of table no.4, the pH value was recorded highest (3.8) in T4 and T8, and lowest (2.80) in T1, T5, T6. There is no significant effect of pre drying treatments on pH value of dried powder. Oven dried powder had more pH value than sun dried sample.

Ash (g/100g)

Ash content of sample increases on drying (table no.2). The highest ash content present in T4(5.91g) and lowest in T2(5.42g).There was no significant effect of drying methods and pre drying treatments on the ash content of dried powder. The minor difference in ash content may be due to the difference in weight of the samples.

Total phenol content (mg/100g)

The increase in the total phenolics is possibly due to the liberation of the phenolic compounds from the matrix during the drying process. Drying might have accelerated the release

of bound phenolic compounds during the breakdown of cellular constituents. The highest total phenol content was observed in T5 (6.87 g), that is sun dried sample pre-treated with normal water and 0.5% KMS, and the lowest in T4(6.10%),that is oven dried sample pre-treated with hot water and 1% KMS (Table no.2)

Ascorbic acid (AA) (µ g/100g)

The AA content of T7(490µg) was found to be highest and T1(310µg) was lowest on the basis of observations made on table no.5.The oven dried sample that was pre-treated with normal water and 0.5% KMS had highest value of ascorbic acid and the sun dried sample that was pre-treated with hot water and 0.5% KMS had lowest value of ascorbic acid. Ascorbic acid content of fresh sample was more than the dried sample (table no.2), this may be due to loss of moisture during drying.

Sugar (%) (Reducing, non-reducing and total sugar)

According to table no.3, The lowest reducing sugar (4.60%), non-reducing sugar (6.20%) and total sugar (10.80%) was found in T4 and highest reducing sugar (4.90%), non-reducing sugar (6.50%) and total sugar (11.40%) was found in T10.It was concluded that, there is no significant difference in sugar content of dried powder, means there was no any effect of methods of drying and pre drying treatments on sugar content of dried sample. The sugar content of fruits increased with drying and this is clear from the data of table no.1, in which the sugar content of fresh and dried sample was compared.

As per the edible fruit composition reported by Gopalan *et al*., (2007) [7] a significant concentrated effect on nutritional composition of wood apple pulp powders was noted. Chemical parameters like titrable acidity, sugar, total phenol, ash, TSS and total antioxidant capacity were significantly higher in dried powder than fresh pulp, while the vitamin C and pH content was drastically reduced on drying.

Table 1: Chemical composition of fresh wood apple fruit pulp

Fresh Pulp	Composition
Moisture Content (%)	65
Ascorbic Acid(µ G/100g)	3200
Tss(%)	19
Titrable Acidity (%)	2.94
Tss/Acidity Ratio	6.46
ASH (G/100g)	1.9
Totalphenol Content (Mg/100g)	2.35
Ph	5.2
Reducing Sugar (%)	2.19
Non-Reducing Sugar (%)	5.21
Total Sugar (%)	7.33

Table 2: Effect of different drying methods and pre-dry treatment on ascorbic acid, ash and total phenol content of wood apple pulp powder

Treatments	Ascorbic Acid (µg/100g)	Ash (G)	Total Phenol Content(Mg/G)
T1	310.00	5.50	6.58
T2	340.00	5.42	6.61
T3	480.00	5.85	6.14
T4	460.00	5.91	6.10
T5	360.00	5.51	6.87
T6	350.00	5.54	6.72
T7	490.00	5.90	6.33
T8	470.00	5.80	6.23
T9	340.00	5.51	6.59
T10	450.00	5.90	6.21
T11	370.00	5.51	6.80
T12	480.00	5.85	6.30
GM	408.33	5.68	6.46
SE(m)±	13.94	0.07	0.03
SE(d)±	19.72	0.10	0.05
CD	40.70	0.21	0.09
CV(%)	5.91	2.19	0.87

Table 3: Effect of different drying methods and pre-dry treatment on reducing, non-reducing and total sugar content of wood apple pulp powder

Treatments	Reducing Sugar (%)	Non- Reducing Sugar (%)	Total Sugar (%)
T1	4.85	6.45	11.30
T2	4.80	6.40	11.20
T3	4.65	6.25	10.90
T4	4.60	6.20	10.80
T5	4.84	6.44	11.28
T6	4.81	6.41	11.22
T7	4.64	6.24	10.88
T8	4.61	6.21	10.82
T9	4.86	6.46	11.32
T10	4.90	6.50	11.40
T11	4.66	6.26	10.92
T12	4.70	6.30	11.00
GM	4.74	6.34	11.09
SE(m)±	0.02	0.2	0.05
SE(d)±	0.02	0.2	0.07
CD	0.04	0.04	0.14
CV(%)	0.55	0.41	0.74

Table 4: effect of different drying methods and pre-dry treatment on pH, titrable acidity,TSS and sugar:acid ratio of wood apple pulp powder

Treatments	Ph	Titrable Acidity (%)	Tss (%)	Sugar Acid Ratio
T1	2.80	11.70	19.60	1.67
T2	2.90	11.90	19.50	1.64
T3	3.51	10.10	20.80	2.05
T4	3.80	10.40	20.40	1.96
T5	2.80	11.50	19.80	1.72
T6	2.80	12.00	19.80	1.65
T7	3.30	10.70	20.60	1.92
T8	3.80	10.20	20.40	1.96
T9	3.03	11.90	19.80	1.66
T10	3.70	10.40	19.70	1.89
T11	3.60	12.00	20.50	1.70
T12	3.76	10.30	19.60	1.90
GM	3.32	11.09	20.04	1.81
SE(m)±	0.10	0.08	0.14	0.02
SE(d)±	0.14	0.11	0.20	0.03
CD	0.29	0.22	0.42	0.06
CV(%)	5.22	1.17	1.25	2.08

Conclusions

The chemical composition of wood apple pulp were studied and it was revealed that it contained moisture 65%, total soluble solids 23%, ash 0.2%, acidity 2.94%, reducing sugar 2.15%, non- reducing sugar 9.5%, total sugar 11.65%, ascorbic acid (Vitamin C) 3.2 mg/100 gm. At drying, Nutrients get concentrated except vitamin C and pH that were lost on drying. So, dried wood apple pulp powder retains more nutrients than fresh the one. There is no more such of pre—drying treatments on the qualities of wood apple pulp powder. The quality is mainly effected by the drying methods. Different sun drying and oven drying methods had significant effect on changes in chemical quality of wood apple pulp powder. Oven dried fruit powder had the highest, moisture (6.0%) TSS (20.80%), AA (490µ g) and pH(4.80) value and TSS/TA(20.80) ratio, lower TA and shorter time of drying. Sun dried fruit powder had lower moisture(5.25%),TSS, AA and pH value and TSS/TA ratio and higher, total phenol content(6.87mg), TA(12%) and longer time of drying (Workneh *et al* 2012). So, in terms of chemical, functional, nutritional and non-nutritional quality, sun dried wood apple pulp powder exhibited highest index than oven dried. Hence the wood apple pulp could be dried effectively using sun drying, preserved as dried powder and value added for its industrial exploitation. Since sun drying is also cost effective, the wood apple pulp could be sun dried, formulated into powder and utilized for the preparation of jam, jelly and other products with good gelling nature even during off-season.

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